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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, Broadway Bldgs., Westminster, S.W. 1, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE NEW PROSPECTUS.

THE attention of persons interested in the training facilities offered by the College may be drawn to the fact that a new prospectus has recently been issued, dated October 2nd, 1939, and superseding all previous issues.

There are several important changes which affect particularly the courses offered for post-graduate students. The Associateship is already recognised throughout the Colonial Empire as the hallmark of a high standard of technical knowledge and ability. But no standard remains for all time fixed, and the conditions of to-day are not those of the early days of the College. To maintain and safeguard the reputation of any academic or technical qualification it is necessary continually to review the conditions under which its holders will be required to work and the kind of instruction best fitted to their needs. The Associateship course will in future take two years except for our own diplomates. It has in fact done so for some time past, so far as the Colonial agricultural scholars are concerned and they have formed the majority of Associates. These cadets normally receive scholarships extending over two academic years of which the first is spent at Cambridge University and the second in Trinidad, and the courses in the two institutions are framed to be complementary. Thus the instruction given in Trinidad, though previously described as a course complete in itself was not so in practice. The position has been clarified by formally recognising the Associateship as a two-year course, of which the first year may be taken either at Cambridge or at this College.

Through close co-operation with the Cambridge authorities a very good two-year course has been evolved. It is not the same course for all students but is adjusted to meet the needs of both general agriculturists and specialist officers. Both classes of students are expected to acquire a broad knowledge of tropical agriculture and of all the branches of science applied thereto. Thus, in the first year of his study, whether it is in Cambridge or in Trinidad, a graduate in Science devotes his time largely to acquiring a knowledge of agriculture, and a graduate in Agriculture is given post-graduate training in science.

With regard to our own diplomates who will be privileged to take the Associateship in one year, we believe that they will have no difficulty in

obtaining the required standard in that time, particularly as the course will be restricted to men of exceptional ability as proved by their performance in the diploma course.

A type of student who might appear possibly to suffer by the changes in our Associateship regulations is the man who, generally after several years' experience in a colonial department of agriculture, wishes to improve his knowledge, but can only afford the time to attend a one-year course at the College. For him, therefore, a Refresher course at considerably reduced fees is offered. When the Associateship course was originally planned it was expected that most refresher students would possess qualifications as good as those of Colonial Office cadets and that with their additional experience they would cover in one year the ground which is covered in two years by the cadets. Such qualifications have proved to be exceptional rather than normal, both for British and foreign refresher students. It is true that some of these students have been highly qualified both technically and scientifically but the majority of them could not be brought up, in the short period of one academic year, to the standard set for the Associateship. To permit such men to take the Associateship would often entail a relaxation of our standard for that qualification. The Refresher course has therefore been provided which we believe will adequately fulfil all their needs. This course is definitely easier and should be ideal for the man who wants to rub up his knowledge of tropical agriculture and other agricultural sciences. It should give him time outside the lecture room not only to study subjects in which he may be particularly interested but also to make the best use of the extensive literature in the College Library.

As hitherto other facilities for instruction offered besides the Associateship and Refresher courses comprise a Diploma course in *agriculture* and Diploma and Associateship courses in *sugar technology*. Except for slight modifications in the syllabus, all these remain unchanged. Applications from students wishing to attend the College for short or irregular periods will also be considered but such students will only be permitted to attend lectures selected from the regular courses and will not be provided with special instruction, nor will they be able to qualify for any certificate. According as to whether they are taken in agriculture or in sugar technology the Diploma courses have been designed to equip students for the management of commercial estates and for junior posts in West Indian agricultural departments, or for junior technical posts in sugar factories. They are primarily intended for West Indian students and it may be of interest to comment on their cost. It is estimated that the essential expenses, exclusive of the cost of passages and tuition fees, incurred by a West Indian student, provided he is reasonably careful, need not be more than £165 or £130 for each academic year according as to whether he resides in the Milner Hostel or outside the College. To all intents and purposes these figures represent the actual annual cost of keeping West Indian students at the College since most of them have scholarships entitling them to free tuition. Particulars of scholarships available to British West Indian students are included in the prospectus.

MISCELLANEOUS NOTES.

Elements of Nutrition.

A survey of up-to-date knowledge of elements which appear to be essential when present in traces in human and animal foods is given by W. Godden (*J. Soc. Chem. Ind.*, 58, 791; 1939). Copper in small amounts appears to be necessary in preventing anaemia in animals, the food of which nevertheless contains adequate amounts of iron; its rôle is not concerned with the assimilation of iron but with the mobilization of iron in the body and with the formation of haemoglobin. Milk is very low in copper as well as in iron, but copper is present in most other foods. Manganese plays no part in haemoglobin formation, but appears to be necessary for foetal development. Cobalt is in some cases essential to iron metabolism, and diseases of farm animals in Australia and New Zealand have shown it to be an essential element in the cure of bush-sickness; traces of nickel may possibly supplement deficiency of cobalt. Zinc does not play any part in iron metabolism; it is present in higher percentage than copper or manganese in human and cow's milk and is a constituent of crystalline insulin. Fluorine is present in bones and the enamel of teeth, but when present in more than mere traces it affects the enamel of teeth; this may be caused by drinking waters containing more than 1.5 parts per million of fluorine. Iodine deficiency has long been recognized as a probable cause of goitre. Selenium is a harmful element, and its presence in soils of the Great Plains of the United States, from which it finds its way into herbage and cereal grains, causes diseases of animals which were formerly regarded as due to the alkali present in the waters of these regions. The paper includes a short bibliography.—(*Nature*, Vol. 144, No. 3647, pp. 556-57, 1939.)

* * *

Flower Shedding and Fruit Drop in Citrus.

According to an article in *Soviet Subtropics*,* citrus fruit drop under the Caucasus and Black Sea Coast conditions has been found to be mainly due to high air temperatures. Flower-shedding is on the other hand attributed to a number of factors, namely, biological characteristics of certain varieties and clones, climatic conditions during the flowering period, incompatibility of stock and scion, lack and excess of nitrogenous manuring, damage done to trees by pests and diseases, aridity of soil and air, lack of warmth in the soil in spring, faulty pruning and inadequate soil cultivation.

* 1939, No. 4 (56), pp. 60-8.

RECENT PROGRESS IN THE CULTIVATION OF TUNG OIL TREES (*ALEURITES FORDII* AND *A. MONTANA*).

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Introduction.

During the past fifteen years plantations of *Aleurites fordii* and *A. montana* ranging from small experimental plots to large estates have been made in almost all tropical and subtropical countries. From the numerous reports which have from time to time been published it would appear that the results so far obtained from these very extensive trials are rather disappointing. No country has yet been able to report the existence of a profitable commercial tung plantation; in many, probably the majority, of the territories results have not been promising or are still very inconclusive, and in many others the trials have been abandoned. In this article it is proposed briefly to summarise progress made in those countries where trials have reached the stage of giving results of interest and to discuss certain difficulties and problems which have arisen and which in part account for the slow rate of progress.

Progress in Territories where Tung has been Extensively Planted.

The U. S. A.—In America planting has been confined to the species *A. fordii* as the few trees of *A. montana* which were planted experimentally did not give results of sufficient promise to warrant more extensive trial. The first plantation of *A. fordii* was established at Gainesville, Florida, in 1912, but intensive development of tung planting did not commence until 1922 when further trials were instituted followed by considerable commercial planting. The total acreage planted in the six states of Mississippi, Florida, Louisiana, Georgia, Alabama and Texas was reported in 1937 to be between 42,000 and 45,000 acres (1). This is, of course, a far greater development than has occurred anywhere else in the world and it includes a number of plantations considerably older than any to be found in other countries. In spite of this, however, very few reliable yield figures are available and those which have been published do not indicate that a flourishing industry has been established. It seems fairly certain that a great deal of unsuitable land was utilised for tung planting in the past and that considerable areas have had to be abandoned. A survey of the tung plantations in the six states mentioned above which was published in 1935 (2) showed that 562 acres of six year old trees gave an average yield of 278 lbs. of fruit "as gathered" per acre. This fruit presumably contained a certain amount of moisture but even if it is assumed that it was air dried this figure is only equivalent to approximately 140 lbs. of seed or 52 lbs. of oil per acre. It was further stated that approximately 300 acres of trees seven to eleven years old gave an average yield of 343 lbs. of fruit per acre, which, on the same basis, is equivalent to 172 lbs. of seed or 64 lbs. of oil per acre. These results certainly cannot be regarded as encouraging as a yield of little more than ½ cwt. of oil per acre from trees over seven years old would not be profitable on a cultivated plantation.

The Netherlands Indies.—Both species have been extensively tried since 1925 but no data regarding the area planted or the yields obtained is available. Results obtained with *A. fordii* have been poor but *A. montana* is said to be very promising. The need for improved planting material has been fully realised and work on selection and vegetative propagation has already been put in hand. The use of *A. fordii* budded on to a *montana* stock is also under trial.

Indo-China.—*A. fordii* is occasionally found growing wild in some districts in the north of the territory but trial plantations have given poor results. *A. montana* is indigenous and common in forest regions throughout Indo-China and has long been planted as a shade tree in coffee plantations and in the neighbourhood of villages. A considerable native industry has been in existence for some time, the fruit being collected from wild and shade trees, and the oil extracted with simple presses and sold locally. For many years also planters have been establishing small plantations of this species, but these have never been successful because, although the trees grew well, the yields obtained were not sufficient to be remunerative. It was concluded that the cultivation of *A. montana* as a plantation crop would not be profitable unless improved planting material were available, and investigations with the object of producing such material are in progress at the experimental stations of Tuyen Quang and Phu Ho (1), (3), (4) and (11).

The U. S. S. R.—Considerable interest has been taken in tung planting for some years but the published information available is very scanty and more attention has been devoted to *Aleurites cordata* than to the other species. Extensive trials with *A. fordii* have, however, been made in Trans-Caucasia and Georgia and the total area under this species in 1937 was stated to be 5,704 hectares.

Australia.—A fairly large acreage has been planted with *A. fordii* in Queensland and New South Wales but although the tree clearly flourishes in certain districts it has nowhere reached the stage of a proved commercial proposition. Reliable yield figures from a fair sized plantation do not appear to be available but isolated trees have given very promising

yields and it has been reported that the majority of trees aged 3 to 4 years old produce on an average 300 fruits per annum. While the results so far obtained are far from conclusive it appears that *A. fordii* is showing more promise in these territories than anywhere else in the Empire.

New Zealand.—Trials in New Zealand have been confined to *A. fordii* since the few experimental trees of *A. montana* and *A. cordata* which were planted did not do at all well. Burns *et al.* (5) report that approximately 5,500 acres of *A. fordii* aged 1 to 6 years were being maintained in 1937 but their survey of the groves revealed a very unsatisfactory state of affairs. Selection of land for tung planting had been very unwise and at best 70 per cent. of the trees had been planted on badly drained, infertile soil. Methods of planting had also been unsatisfactory and it was further suggested that the summer temperatures experienced in North Auckland might not be sufficient to bring the fruit to maturity every year. Several plantations have apparently already been abandoned and only one or two growers are continuing to extend their acreage. Another report (6) states that in 1938 there were in New Zealand 55 acres of apparently satisfactory trees, 733 acres of unsatisfactory trees, and 3,760 acres of dead or dying trees.

India and Burma.—Trials have been made with both species in the Dehra Dun District, in Assam, and in the Ranchi District of Chota Nagpur. No conclusive results have yet been obtained but the indications are that *A. montana* is more promising than *A. fordii*. In Burma the results obtained from experimental plantings in the more tropical districts have been unsatisfactory but prospects are very much better at the higher elevations of the Shan States, where at least one large commercial plantation has been established. It is quite clear that *A. montana* is very much more promising than *A. fordii*. The former species grows in a semi-wild condition in small patches throughout the Shan States probably having been introduced from China by Buddhist monks.

East Africa.—Trials with *A. fordii* have been made in Kenya by the Agricultural and Forestry Departments and by a number of European planters. The general conclusion has been drawn that this species is not promising and that no further planting can be recommended. A few trials with *A. montana*, commenced more recently, show distinctly better promise. The position is somewhat similar in Tanganyika. In Uganda, both species have been planted on a small scale but without encouraging results (7).

More progress has been made in Nyasaland than in any other African Colony. Rather more than 2,000 acres had been planted on European owned estates by the end of 1938 and this area has been considerably extended by further planting during the last rains. Both species are being grown but there is probably rather more *montana* than *fordii*. Records of yields are not yet available to any extent as almost all the trees are less than five years old; it is therefore not possible to make any conclusive comparison of the two species. The writer is of the opinion, however, that *A. montana* is so far distinctly more promising than *A. fordii*. The yields of two of the oldest experimental plots are of interest although they do not necessarily represent the full potentialities of young trees as the *montana* plot is not situated in the most suitable area for tung and the *fordii* trees have received no cultivation except cutlassing of the grass once or twice a year.

Table 1.—Yields of experimental tung trees, Nyasaland.

Lbs. of air dried seed per tree.

A. montana (128 trees) Agric. Dept. Zomba 3,500 ft.	Age yrs.	3	4	5	6	7
	Yield lb.	1.75	3.6	6.64	9.46	11.02
A. fordii (62 trees) Forestry Dept. Zomba. Approx. 4,500 ft.	Age yrs.	7	8	9	10	11
	Yield lb.	0.37	0.75	1.6	1.85	2.35

Some account of the cultivation of *A. montana* in Nyasaland has already been published (8).

Conclusions.

From a consideration of the results reviewed above two points emerge:

(*i*) Tung oil has nowhere yet been successfully established as a profitable plantation crop.

(*ii*) Although it is not possible to obtain yield figures in order to effect a comparison of the two species over a period of years it appears that in all the tropical countries where both have been tried (Netherlands Indies, Indo-China, India, Burma, East African colonies) *A. montana* has been found to be the more promising. This fact in itself has delayed progress in the Empire since almost all the earlier trials were made with *A. fordii* and it is only comparatively recently that the better results have been obtained with *A. montana*. The writer has had opportunities of comparing the two species in Burma and in Nyasaland. In both territories *A. montana* grows much more rapidly than *A. fordii* and attains a far greater size: the latter may be compared to an apple tree in size whereas the former reaches a height of 60 to 70 feet when growing semi-wild in the Shan States. *A. montana* starts bearing earlier than *A. fordii* and gives much bigger yields in the first few years and, in view of its much greater bearing surface and the fact that it bears its fruit in clusters whereas the majority of *fordii* trees are of the "single" type,

it seems probable that it will always yield more than *fordii*. Even when allowance is made for the proportion of "male" trees always found in a plantation of *A. montana* (see below), and for the fact that *fordii* can be planted at least twice as densely, the indications are that *montana* will still give the greater yield per acre.

Methods of Establishing Plantations.

Germination of Seeds.—Difficulty in obtaining germination of tung oil seeds has been reported from all parts of the world and led to considerable delay in establishing the earlier trial plots where the seed had to be imported from China or America. This trouble will probably always be experienced where imported seed which had had to stand a long sea journey is used, and no practicable way of improving the germination capacity of such seed has been found although loss of viability may be minimised by transporting the seed in the husk and by careful packing. When, however, seed can be obtained locally, satisfactory germination can usually be obtained provided that the seed is sown as soon as possible after harvesting. It should be sown in ordinary nursery beds without shade at a depth of 1½ inches and a spacing of about 9 inches each way, the soil being kept as moist as possible without it becoming cold. The germination capacity decreases the longer the seed is kept after harvest and keeping the soil thoroughly warm assists in obtaining good results. Mulching or shading of the nursery beds is therefore unnecessary unless the weather is particularly hot and dry.

Transplanting.—In the absence of previous experience of growing the trees as a plantation crop planters have had to try out a variety of methods of establishing their groves and in many cases this lack of knowledge of the procedure most suited to local conditions has resulted in relatively poor growth being obtained and has thus delayed progress. Probably the best way to establish a field of tung is to transplant seedlings nine to fifteen inches in height from the nursery bed early in the rains. Seedlings of both species are inclined to be tender and precautions should be taken to prevent wilting by transplanting with a ball of earth about the roots, working on a rainy or overcast day, removing some of the leaves or shading, &c. The best results are obtained if the seeds are sown in baskets and all disturbance of the seedlings avoided by transplanting them in the baskets, but although this method is of value in planting small experimental plots it is probably too expensive for application on a commercial scale. Plants may also be allowed to remain a year or more in the nurseries where they can be cut back to a foot or eighteen inches of wood and transplanted as stumps. While satisfactory plantations of both species have been established in this way the use of small seedlings usually results in better growth. In certain districts in Nyasaland, where a little rain can be relied upon during the dry season, some planters have found it advantageous to plant tung as stumps early in the dry season when their labour is not much required for other crops. These stumps make no growth above ground until the commencement of the following rains when they come away quite well. Good results have also been obtained by sowing seed at stake in the field but this method is not as reliable as the use of nursery plants and is not to be recommended unless climatic conditions are known to be favourable and a plentiful supply of relatively cheap seed is available.

Spacing.—Reports indicate a great deal of variation in the planting distances employed for both species. The spacing will naturally vary with soil conditions, &c., and at present so little is known of the growth of the trees beyond the first few years that no very definite recommendation could be made. Clearly *A. montana* requires a much wider spacing than *A. fordii*. Full sized trees of the former species will probably need to be 40 to 60 feet apart but as they do not attain to their full size for some years it will be more profitable to employ a closer spacing when planting and to thin out later as required. It is suggested that the information now available indicates an original spacing of about 18 feet for *A. fordii* and about 30 feet for *A. montana*, both on the triangular planting system.

Subsequent Attention.—No special points can be made concerning subsequent attention to the trees. Pruning appears to be unnecessary except for the removal of dead wood or crowded branches. Some young trees always produce shoots from the base of the stem and if a clean trunk is required these should be removed. If they are left the tree will develop a bushy shape but there is no reason to suppose that this is a disadvantage except that in the case of *A. montana* some trees which branch very low tend to split when three or four years old. Manurial trials have been carried out in various places, notably in America (9), but while most of them have shown a response to the manure in increased growth and yields the manuring has not been proved to be profitable, and in the absence of any definite knowledge of the cropping capacity of the trees no general recommendation regarding manuring could be made at present.

Selection and Vegetative Propagation.

It has been almost universally noticed that both species show great variation in vegetative characters, in their method of flowering and in yield. The variation in flowering habit is of great importance as it directly affects yield but as yet there is not very much information available on the point and further study is very necessary. Both species are monoecious but individual trees differ very much in the proportions of male and female flowers which they bear especially in the case of *A. montana*.

The *fordii* inflorescence consists of one or more central female flowers surrounded by a large number of males. Clusters with a single central female flower are by far the commonest but there are also trees which bear a number of female flowers in each cluster and some with many entirely male clusters. Some study of this and other variable characters in *A. fordii* was made some years ago in Florida (10) but no further work has been reported.

Trees of *A. montana* may bear inflorescences, which are entirely female, entirely male, or which contain flowers of both sexes. The most important source of yield variation has been found in the fact that in any plot of this species a proportion of the trees are entirely male or at the most have only a few clusters containing female flowers. This feature was studied at the Tuyen Quang Experimental Station in Indo-China in 1929 and 1930, by counting the numbers of male and female flowers on 599 trees, when the following figures were obtained (1):—

Table 2.—Classification of *A. montana* trees by percentage of female flowers.

Percentage of female flowers.	Percentage of trees in each category.	
	1929	**1930**
0	29.5	22.8
0- 5	15.8	22.0
5- 15	4.8	5.5
15- 25	3.8	3.7
25- 40	2.8	2.5
40- 60	4.8	3.8
60- 75	2.5	3.3
75- 85	2.8	2.2
85- 95	3.5	4.2
95-100	9.7	14.3
100	20.0	15.7

It will be seen that approximately 44 per cent. of these trees had less than 5 per cent. of female flowers in each of the two years. The writer has also made rough estimates on two plots of young *A. montana* of the number of trees which bore no more than a few clusters containing females and obtained in both cases a figure close to 40 per cent. These trees are usually very striking in a plantation as they are commonly above average size and flower very profusely but needless to say they yield little or no fruit. It has been suggested that such trees may undergo a change of sex as they grow older. The figures in Table 2 indicate that some change does occur from year to year and the writer has noticed that trees which are entirely male one year may bear a few female clusters the following year. It is noticeable, however, that the trees at Zomba, which are now eight years old, so far show no *appreciable* change of sex and as most of these "male" trees are large and more vigorous than those already cropping well it seems very doubtful if it can be assumed that the production of only male blossom in the early years is a temporary measure permitting a strong vegetative development of the tree before fruiting. On the other hand it has been claimed in Indo-China (11) that even if the proportion of females is an hereditary factor it is equally influenced by climate and soil. Further investigations are needed, but the writer is convinced that there will always be a proportion of unprofitable trees in any plantation of *A. montana* established from unselected seed, and there is little doubt that the same applies to *A. fordii*. There is clearly urgent need for yield recording of individual trees with a view to the selection of high yielders, and the vegetative propagation of material from these good trees, and it is quite possible that only by utilizing such improved planting material will it be possible to establish profitable plantations. The budding of scions from good mother trees on to seedling stocks is likely to be the most useful method of effecting improvement at first, and the possibility of converting "male" trees of *A. montana* by top working is also well worthy of investigation.

Selection has already been commenced in some countries, notably in Java, and in Indo-China where seed from selected high yielders is already being distributed (11). A certain amount of work has also been done on vegetative propagation, particularly bud grafting. Patch budding of *A. fordii* was successfully carried out at Gainesville, Florida, some years ago (10) and has since been used elsewhere. The same species has been both budded and grafted at the Subtropical Horticultural Research Station, Nelspruit (12), and budding by the shield and patch methods has also been successful in Brazil, Malaya and Java (1). In Russia experiments were made over a period of three years with ring budding, patch budding, and shield budding of *A. fordii* and *A. cordata*, the first method giving the best results, with 95-100 per cent. of takes (13). Other Russian trials at Batum gave similarly good results with shield budding (1). The writer has used the method normally employed with rubber quite successfully for the budding of *A. montana* and *A. fordii* on to seedling stocks of *fordii*, *montana* and *moluccana*. Other methods of vegetative propagation, likely to be of use in the multiplication of clonal root stocks, have not yet received much attention. It has been stated that both *A. fordii* and *A. montana* have been raised from stem cuttings in Java (1), but negative results were obtained with this type of material in America (9), in Russia (1) and by the writer. In Russia (1) it is stated that *A. fordii* has been propagated from layers and all three species (*fordii*, *montana* and *cordata*) from root cuttings. The writer has raised a few plants of *montana* and *fordii* from layers and of *A. fordii* from root cuttings.

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THE RELATIONSHIPS OF *GOSSYPIUM RAIMONDII* ULB.

By J. B. Hutchinson.

Empire Cotton Growing Corporation, Cotton Research Station, Trinidad, B.W.I.

Gossypium raimondii was described by Ulbrich (1932) from imperfect material from valleys in the Peruvian Andes. Seeds were obtained in 1937 from the Ministry of Agriculture, Peru, and have been grown at the Cotton Research Station, Trinidad. Ulbrich's description requires amplification with regard to the seed, which is covered with a dense irregular coat of greenish hairs, fading to brown with age. The longest hairs are up to 10 mm. long, but there is no differentiation into separate coats of lint and fuzz.

Chromosome counts were made in root tip material by R. M. Madoo. Root tips were fixed in Lewitsky's fixative (Skovsted 1935) and stained in Gentian Violet. A typical plate is reproduced in Fig. 1. The chromosome number 2n=26 was verified on 11 plates.

Fig 1.

Gossypium Raimondii. Root Tip Division (× 3400).

G. raimondii is morphologically similar to *G. klotzschianum* and *G. davidsonii*, which also have 2n=26. It differs from them in having very much larger leaves and flowers, a dense tomentum all over the younger parts, and a fuzzy instead of nearly naked seed. In its crossing behaviour, however, *G. raimondii* is very different from the other two species. The results of inter-species pollinations involving *G. raimondii* are summarised in Table I.

Table I.

Crossing behaviour of *G. raimondii.*

Crossed with	raimondii used as	Crosses made.	Bolls set.	Seeds obtained.	Plants obtained.
G. klotzschianum	Male	72	0	—	—
	Female	2	1	6 (empty)	—
G. davidsonii ...	Male	17	8	115 (empty)	—
	Female	2	0	—	—
G. aridum ...	Male	34	1	(fell 16th day)	—
	Female	7	0	—	—
G. armourianum	Male	5	0	—	—
	Female	7	0	—	—
G. trilobum ...	Male	7	0	—	—
	Female	11	0	—	—
G. barbadense ...	Male	117	46	279	163
G. hirsutum ...	Male	5	4	20	7
G. purpurascens	Male	14	14	65	53
G. religiosum ...	Male	20	6	69	16
G. darwinii ...	Male	20	2	23	2
G. taitense ...	Male	47	1	6	3
	Female	2	0	—	—
G. sturtii ...	Male	5	1	24	1
	Female	6	0	—	—
G. anomalum ...	Male	11	4	52 (empty)	—
G. stocksii ...	Male	23	0	—	—
	Female	3	0	—	—
G. arboreum ...	Male	79	40	674 (empty)	—
	Female	13	3	44 (empty)	—
G. herbaceum ...	Female	15	2	7 (empty)	—

[Species names as accepted by Skovsted (1937)].

G. raimondii gave viable hybrids, which grew to maturity and flowered, with all n=26 chromosome species tested, and with *G. sturtii*. With *G. aridum*, *G. armourianum* and *G. trilobum* no successful crosses were obtained, and with all other species, crossing resulted in the production of empty seeds. *G. klotzschianum* and *G. davidsonii* gave viable hybrids with *G. sturtii* and *G. anomalum* only.

Skovsted (1937) suggested that the failure of hybridisation between *G. davidsonii* (and *G. klotzschianum*) and other New World n=13 chromosome cottons might be due to genetic incompatibility. The failure of hybridisation between these two and *G. raimondii* in some measure supports this theory, but *G. raimondii* does not even give empty seeds with *G. aridum*, *G. armourianum* and *G. trilobum*. On the other hand, it crosses freely and gives vigorous hybrids with the n=26 chromosome cottons.

In spite of the failure of crossing between them, *G. raimondii* must be grouped with *G. klotzschianum* and *G. davidsonii* on account of their morphological similarity, and these three must be regarded as rather widely separated from the other New World cottons with n=13 chromosomes.

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SOME ECONOMIC ASPECTS OF THE DEPRESSION IN TRINIDAD'S CACAO INDUSTRY.

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Depressions and recessions in trade have become the bugbears of economic life today, and agriculture appears to share in them to an equal, if not to a greater extent than urban industry. Trinidad at the present time furnishes a good example of depression in its cacao industry. The fundamental causes of such depressions are not generally understood even by the most educated and influential persons and consequently action taken to combat them is often of a misguided character. Lack of understanding of the causes of depressions are particularly noticeable in respect of agriculture and it is thought therefore that a theoretical examination of these causes with particular reference to the Trinidad cacao industry can be profitably undertaken.

It must be realised at the outset that there are two quite dissimilar causes of depression in agriculture, one external and transitory, the other internal and more or less chronic. Let us first take the depression caused by forces outside agriculture.

The trade cycle which results in alternative booms and depressions in urban industry has its repercussions on agriculture. The feature of the trade cycle that affects agriculture most is the upward trend of prices during booms and the downward trend during slumps. There are other features of the cycle which vitally affect urban industry, such as the decrease in employment and the curtailment of the volume of production, but these do not affect agriculture directly.

The direct effect of a slump on agriculture is that a falling level of general prices reduces farmers' profits. Farmers cannot avoid incurring expenditure long periods before they receive cash for their harvested produce; money, in fact, is invested over lengthy periods of time in any form of agricultural production. In the case of cacao money is invested in the initial planting and maintenance of the young fields, an investment which may last from twenty to eighty or one hundred years; and in all production operations varying in length of time from nearly a year in the case of cultivation performed at the beginning of the crop year, to less than a week in the case of marketing operations. Even if the costs of all these investments fall at the same rate as the general price level (which they rarely do), the planter and the farmer cannot avoid low profits because his investments are made at a time of high prices relative to the time at which he sells his produce.

This effect is reversed in times of rising prices, but the farmer does not necessarily retrieve all the losses he incurred when prices were falling. When prices are rising the farmer admittedly earns a premium on his "investments" due to the rise in prices during the interim between expenditure and sale of produce; but conditions at the beginning of a period of rising prices are not the same as they were at the beginning of a slump. During the period of falling prices farmers attempt to increase the total profit of their farms in the only way possible, by increasing production. Increased production, of course, has the effect of depressing agricultural prices to below the general price level, and of intensifying the depressions in agriculture; the total income to the agricultural community is not appreciably increased and ultimately the total profits in agriculture are less than they would have been if farmers had not increased production. The result of this trend is that at or about the trough of the depression agriculture is in a depleted financial condition and unable to take full advantage of rising prices. Production which has increased to an unduly high level during falling prices contracts towards the end of the period because of the exhaustion of capital reserves both in the bank and in the soil. In such an exhausted condition agricultural production cannot re-expand rapidly when prices commence to rise; consequently agricultural prices jump suddenly to above the general price level but farmers do not receive the full benefit

of the jump because of their small volume of production. The subsequent rise in agricultural prices, retarded by the re-expansion of production, is less rapid than the rise in general prices and less rapid than the previous decline. Farmers, therefore, gain less in a time of rising prices than they lose from an equal fall in prices.

The effect of the trade cycle on agricultural prosperity is evidently a transitory one. It is true that during a succession of equal depressions and booms agriculture on the average is less prosperous than industry, but the intense depression caused by a slump disappears in agriculture and industry alike when the general price level takes an upward trend.

The present depression in the Trinidad cacao industry is probably not due in any more than a small degree to the general fall in world prices. It is, however, to a small extent due to this cause. The poverty-stricken condition of the industry today is partly attributable to the continued downward trend in cacao and general prices since 1925, which has so impoverished the industry that production has decreased and profits almost disappeared. There is, however, another and more important set of causes which account to a far greater extent for the depression in cacao; these causes are due to the internal organisation of the industry and apply as much to agriculture in general as to cacao in particular. They result in a permanent so-called "depression" and are generally not understood or even recognised by either administrators or agriculturists.

To understand the causes of this type of depression we must go right back to the fundamentals of economics—to the axiom that the economic wealth of a community depends on the total effectiveness of its labour; or in more every day language, the amount of commodities (or services) an individual or community can consume in a year is limited by the quantity he or it can produce in that time. The next step in the theory is the assumption that individuals of unequal effectiveness are competing in the sale of the same goods; the quantity consumed under these conditions is limited by the least effective producer whom the least discriminating consumer will permit. The least effective producer will always be producing under conditions of relative depression; his profits will be less than those of any other producer, but they will be sufficient to induce him to continue production.

In agriculture this theory holds good in general. There are tremendous differences in effectiveness of labour in all branches of agriculture, not only because of the genius of the individual in the extremely complex art of his industry, but also because of variations in natural suitability of certain districts to the production of certain crops. The only qualification we have to make to the general theory as applied to agriculture (and it is a very important one), is that the least effective producer is not, as in urban industry, the one who demands the highest price or the one who requires the highest price to continue production. The peasant proprietor the world over is the least effective producer: he expends more labour on the production of his saleable crops than any other. But he is willing in return for certain economic and non-economic amenities, to accept less for his labour than other producers and consequently continues production at very low prices. There are, admittedly, certain districts and certain types of agriculture in which very high labour requirements are necessary and in which the peasant is equally as effective as other producers, but these are isolated and unimportant exceptions. The reason why all agriculture today is not in the hands of peasants is of course that they are too ineffective to produce sufficient food for the support of urban industry; industry must turn for the balance of its food to the more productive farmers, who paradoxically undertake production only if higher prices are offered.

The prices of agricultural commodities then are determined not by the least effective producer necessary to give the total required supply, but by the least effective producer *after* the peasant proprietor. The agricultural industry indeed is composed of a vast bulk of inefficient producers (the peasants) together with a gradation up through relative effectiveness from the marginal to the most efficient non-peasant producer.

Now with most agricultural products a very large proportion of the total supply comes from peasant holdings or family farms. There is always a tendency therefore for prices to be lower than the level tenant and estate producers are willing to accept. If, however, any large body of these other producers retire from production, there is a disproportionately large rise in prices because of the relatively inelastic demand for agricultural commodities. The existing producers, particularly the peasants, do not and in most cases cannot increase their production to profit by these increased prices, and the abnormally high prices will persist unless the producers who withdrew re-enter production. Actually the profits from farming rise to such an extent by the withdrawal of some producers that these producers are attracted back to the industry and the low price level again persists. It is in this way that many of the less efficient non-peasant producers carry on production permanently at a profit rate less than would be tolerated in urban industry, and less than they feel is their moral right. This is how the apparently permanent state of depression in agriculture arises.

It is obvious that the Trinidad cacao industry is today producing in direct competition with peasant proprietors in other parts of the world, no less suited or very little less suited to cacao production than this island. The reactions outlined above are therefore operative, and it seems clear that under these conditions cacao prices are likely to remain low. The prices at present are probably at their lowest, but the planters who wistfully hope that cacao may rise

permanently to $12,00 or $15.00 per hundredweight undoubtedly take an over-optimistic view of the situation.

The severity of the depression at the present time is intense because equilibrium between peasant and plantation production has not been established. A similar period of equalisation must always be experienced in any recently introduced crop. This period is particularly painful, because unlike industrial commodities, the production of these crops does not expand by less and less effective producers entering production. In industry the most suitable district and the most suitable individuals in the main start production, and sell their products at the lowest price; as the market expands and prices rise, less effective producers enter. No such process takes place with the crops under consideration: the first producers in the commercial sense are the educated and enterprising founders of estates; the peasant is sometimes the pioneer of new crops but not the producer of large and regular quantities. As the market for the new crop expands, first less and less efficient plantation producers enter and finally, either on their own initiative or on that of the State, peasants in large numbers enter the field. When peasant farming contributes an appreciable proportion of the total supply, prices fall, because peasants are willing or are outwitted into selling their products at lower prices. The painful process then commences: some of the less effective estate owners cannot in the long run produce at the lower price levels and must in the end be squeezed out of production.

This appears to be the underlying cause of the difficulties of the Trinidad cacao industry. Unless some exceptional increase in the demand for cacao occurs—an increase that is too rapid for peasant producers to meet by their normal rate of expansion—some of the cacao estates will certainly go out of existence. The number of estates which will suffer in this way depends on the ultimate extent of peasant production of cacao and upon the ultimate efficiency of estate production. The estate producer, however, should realise that if he is to compete successfully against the peasant and thereby be sure of a profitable market, he must have a cost of production per bag, including what he thinks is a reasonable profit and rate of interest on his capital, of about what the peasant will accept per bag for the maintenance of himself and his family. It would not be necessary to reduce plantation costs to this level if the crops of peasant agriculture could never furnish the total supply, but that is the level of cost the estate producer must aim at if he is to be certain of survival.

In all agriculture it is obviously a misdirection of public funds to attempt to bolster up estates which on the entry of the peasant into production become very unprofitable unless these estates are susceptible of great improvements in efficiency. Nevertheless the funds could more effectively be spent first on improvement of the best estates which with a relatively small increase in efficiency could successfully compete with peasant production.

One thing is certain. The mere bewailing of the present depression, a common refuge of farmers all over the world, is no solution to Trinidad's present problem. Now that peasants are in cacao production, comparatively low prices have come to stay. What is required is an energetic policy to increase the efficiency of estates. Only as a result of such a policy can the planter sell his goods at the same price as the peasant and earn a reasonable profit.

THE CULTIVATION OF CINCHONA*.

In this bulletin the cultivation of quinine, mainly as carried out in the Dutch East Indies and in the Belgian Congo is described. When seed is used it is sown as soon as ripe in specially prepared beds of light soil under shelters consisting of enclosures formed with moveable bamboo shutters surmounted by a palm thatch roof. The seed beds are kept dark till germination begins a month or so after sowing. Light and air are then gradually admitted. Trouble is often experienced from fungus attack. This can be greatly reduced if the ventilation and watering after germination receive proper attention. Vegetative propagation (grafting) is necessary to preserve the high quinine content of the selected clones, although soil and climate may even then exert a modifying influence. *Cinchona succirubra* and *C. robusta* are the usual rootstocks. Their roots contain three times less quinine than those of *C. Ledgeriana* which is usually the scion variety. The type of graft used is the side graft made as low down as possible on stocks of pencil thickness. The cut penetrates into the wood to about one-quarter the stock diameter. In Java the scion has two joints and the leaves are left on, though cut to one-third. In the Congo the leaves are removed altogether. A transverse incision in the stock 10 cm. above the union is said to improve the percentage of success. The first plantings are close, about 10,000 to the hectare. The first returns are secured when the trees are about three years old and are obtained from prunings of the lower branches or the removal of multiple trunks. This continues in successive years until the branches have been removed to a height of 1.80 metres. A regular thinning of the plantation provides a further yield. A thinning takes place whenever the branches of adjacent trees begin to touch. When growth slows up, that is in 9 to 15 years according to locality, the remaining trees are removed. Methods of bark removal and subsequent treatment are described. The paper contains a great deal of practical information which cannot be condensed.

* *Cinchona* by E. H. J. Stoffels. *Publ. Inst. nat. Etude agron. Congo belge*, Ser. tech. 24, 1939, pp. 51, bibl. 48, 18 fr.

LATENT INFECTIONS IN TROPICAL FRUITS.*

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A study of storage rots of tropical fruits has shown that the fungal pathogens can be divided into two groups, namely, wound parasites and those which are able to penetrate unwounded fruits. Examples of common wound parasites are *Penicillium digitatum, Penicillium italicum, Rhizopus nigricans* and *Botryodiplodia theobromae*. The method of entry of the *Penicillia* into citrus fruit is well known, and recent work in Trinidad has shown that *Botryodiplodia theobromae* infects grapefruit through the cut stem end. Fungi which can penetrate unwounded fruits include species of *Phytophthora* which usually cause an immediate breakdown of either green or ripe fruit, for example, *P. parasitica* and *P. citrophthora* on citrus, *P. palmivora* on cacao and *P. infestans* on tomatoes. The pathogens to which special attention is directed in this paper include a number of fungi from different systematic groups which can gain entry into unwounded green fruits and produce dormant or latent infections in the superficial tissues but show no further activity until the fruits have become ripe or senescent. Such infections may thus remain invisible to the naked eye for months between their initial establishment and their further development.

Colletotrichum gloeosporioides, the cause of 'anthracnose' of many tropical fruits, is the most common fungus in which this type of parasitic behaviour has been observed, but *Phomopsis citri* and a *Guignardia* species also occur. (Here the name *Colletotrichum gloeosporioides* is used in its widest sense, and includes species such as *Gloeosporium fructigenum* and *Gloeosporium musarum*.). *Botryosphaeria ribis,* the cause of a soft rot of the avocado, mango and other fruits has been shown by Horne and Palmer to persist as mycelium in the sub-stomatal air-spaces of developing avocado fruits, its pathogenic activities being arrested until the tissues reach a certain stage of maturity or senescence. It seems probable that certain temperate fungi such as the Apple Scab Fungus, *Venturia inaequalis,* may also behave in this way, or as true latent infections.

Most of the work on latent infections in Trinidad has been carried out on fruits without lenticels such as citrus and papaws but it has also been demonstrated that similar infections occur between the lenticels of the mango. As the stomata of citrus fruits are too small to admit the spores of *Colletotrichum gloeosporioides,* it may be accepted that any cultures obtained by plating out pieces of tissues from a fruit which has been efficiently surface sterilised must have come from within, *i.e.* they must have been present as true latent infections.

Even the smallest fruits of citrus and mango including those newly set contain latent infections of *Colletotrichum gloeosporioides.* It is thought that such fruits are infected directly from spores produced in the decaying floral parts, and also from lesions on young leaves of trees such as the mango which are subject to a leaf blight caused by the same fungus. In citrus, where the leaves are not so attacked, the source of spores is probably dead wood. Young fruits of trees suffering from blossom-blight (*Colletotrichum gloeosporioides*) are probably heavily infected from the outset.

Evidence has been obtained that as well as citrus fruit, mangoes and avocadoes, other fruits such as bananas, tomatoes, papaws, and cacao, are heavily infected by these 'latent infection' fungi long before any storage rots develop. The papaw is peculiar in that although latent infections of *Colletotrichum gloeosporioides* are established at the stem and stylar ends of young fruits, they do not occur on the sides of the fruit until it begins to ripen. This may perhaps be explained by the fact that the waxy coating of the young fruit does not allow water to lie on it sufficiently long for infection to take place.

The study of latent infections in the tissues presents considerable technical difficulties. In the grapefruit it has been shown by cultural methods that they only occur in the epidermal and possibly in the outer parenchymatous layers, but so far attempts to demonstrate their presence in fixed and stained preparations have been unsuccessful. In the papaw, however, it was found that *Colletotrichum gloeosporioides* could be established without difficulty on fruit of any age and the course of infection has accordingly been studied in some detail. When a spore suspension in water is applied to the surface of fruit at tropical temperatures (80°–90° F.) the spores germinate rapidly and form appressoria in about nine hours. A saturated or nearly saturated atmosphere appears to be necessary for spore germination and the formation of appressoria. The subsequent development of the appressorium does not appear to require such moist conditions and penetration of the epidermis occurs after about 24 hours. In some instances the establishment of latent infections by direct entry of germ-tubes into stomata may apparently occur. Fruit of any age can be infected in this way, the subsequent behaviour of such artificial infections being closely comparable with normal latent infections. Heavily infected tissues obtained by artificial inoculation as described above have been prepared for microscopic study. In this way it is hoped to extend

* This paper was submitted to the Imperial Mycological Conference. Arrangements had been made to hold this Conference in London last September, but these were cancelled on the outbreak of war.

our knowledge by a study of latent infections *in situ*. In this connection mention should be made of preliminary studies on the infection of tissues by *C. lindemuthianum* undertaken by Dey.

The study of latent infections has found a practical application in the control of mango anthracnose. At present in Trinidad and elsewhere in the moist tropics wastage in stored mangoes, caused by *Colletotrichum gloeosporioides*, is severe, and to a considerable extent precludes the successful export of this fruit. Knowledge of the important part played by latent infections provides a direct clue to the methods which should be adopted in attempting to control wastage. It has been shown that weekly applications of Burgundy Mixture, though uneconomic, give a satisfactory control of the disease. As latent infections may be established throughout the period of development of the fruit it is unlikely that one or two routine spray applications during the season will give an adequate control of the disease. There are, however, indications that in certain seasons five sprays will produce a very definite reduction in the intensity of the infection.

Knowledge of the type of parasitism displayed by different fruit rotting fungi and information on specific points such as time of infection, *i.e.* before or after harvesting, are of great practical value: it is considered that the study of the latent infection fungi has yielded, and will continue to yield results of considerable interest.

Once a fungus has become established as a latent infection in a young fruit, its subsequent activity cannot be divorced from the physiological behaviour of the fruit during development, ripening and senescence, *i.e.* the superficial tissues penetrated constitute the environment in which the pathogen must live. The outstanding fact so far established is that during the development of the fruit the fungus remains quiescent as an inconspicuous mycelium of arrested growth—a state of affairs which still awaits investigation. With the onset of ripening, however, the environment in which the pathogen has for so long remained inactive undergoes far-reaching changes, the resistance previously offered to fungal activity diminishes, and a renewal of hyphal growth becomes possible, culminating in the production of typical disease spots or lesions. In fully-grown fruits ripening normally at tropical temperatures these lesions usually become apparent at stages in ripening or senescence which can be precisely specified by various physiological observations. Not infrequently anthracnose spots occur within one or two days of the attainment of the 'eating ripe' condition. In so far as the normal metabolic trend in the ripening of fruit may be modified by various treatments, involving changes in the fungal environment, so also is the course of development of latent infections affected. Notable examples which may be cited include the abnormally early appearance of latent infection spots in fruits which have been subjected to low temperature injury during cold storage and in fruits to which certain chemical treatments have been applied. In other words, the operation of certain factors induces a premature loss of resistance to latent infections. A knowledge of the interrelated physiological and pathological aspects is thus not only of considerable academic interest but of great importance in the storage of tropical fruits.

THE LOCUST PROBLEM.

The latest survey on the locust problem, by Dr. B. P. Uvarov in collaboration with Miss W. Milnthorpe, has recently been published on the recommendation of the Special Committee on Locust Control appointed by the Economic Advisory Council (H.M. Stationery Office, 3s. net). It is gratifying to note that the international co-operation for collecting information relative to locusts continues in an efficient manner. The present survey deals with the locust problem in 1937, and it demonstrates once again the importance of keeping continuous watch over developments in the situation.

The desert locust (*Schistocerca gregaria*) did not give rise to swarms during the period of review either in South Africa or in India. On the other hand, the situation in the Sudanese-Arabian area during the winter of 1937-38 gave rise to anxiety. In the early months of 1938, it was reported as breeding in the gregarious phase in several localities along the western coast of the Red Sea. No evidence of actual swarming has been recorded, and this is evidently due to the success of the control measures that were applied. This hopeful event should well justify the establishment of proper organizations for the purpose of watching those areas known to be areas of swarm production. In this connection it is mentioned that preliminary arrangements for such organizations on an international basis are progressing very favourably.

As regards the African migratory locust (*Locusta migratoria migratorioides*), all the eastern part of Africa remained free from this insect during the first half of the year under survey. Later in the year, however, the situation changed. Swarms appeared in West Africa and spread eastwards, with the result that the Anglo-Egyptian Sudan became reinfested by this species after an interval of two years. This invasion does not, however, appear to be an entirely new outbreak and its origin seems to have been in districts of Oubangui-Chari, and farther to the west, where swarm production has been noted for the last two or three years.

The red locust (*Nomadacris septemfasciata*) has shown a slow decline in its outbreaks. While there was no marked reduction in the area under infestation, in many instances the swarms were smaller and not so dense.—(*Nature*, Vol. 144, No. 3636, p. 86, 1939.)

NUTRITION IN THE COLONIAL EMPIRE.

Introductory.

THE Report on Nutrition in the Colonial Empire* which has recently been published is a document of considerable importance. It has been prepared by a committee of the Economic Advisory Council under the Chairmanship of Lord De La Warr. The committee was set up to consider the information received as a result of a circular despatch sent out while Mr. J. H. Thomas was Secretary of State for the Colonies. It will continue in being to advise on matters affecting nutrition in the Colonial Empire. Attached to the report is a second volume† containing a summary of the information available about nutrition in the different parts of the Colonial Empire. In a foreword, the Secretary of State for the Colonies says that "the fact that Colonial Governments have already ordered over four thousand copies of the report indicates impressively the importance which they attach to it and the wide distribution which they contemplate. "I hope" he continues "that it will also be studied by employers of labour in the Colonial Empire, by missionaries and by all others interested in the welfare of its people."

Colonial Dietaries and Effects of Malnutrition.

The committee has no doubt that improved nutrition could bring very great benefit to the Colonial Empire, not so much by the eradication of disease, though this is important, as by a general improvement in the standard of health and well-being. After a chapter in which the principles of correct nutrition are clearly set out, the report discusses the principal characteristics of Colonial dietaries. The latter have been found to be predominantly vegetarian, in most parts of the Colonial Empire only very small quantities of animal products being consumed. Milk in particular is very rarely consumed indeed. Many peoples also in the Colonial Empire are very dependent on a single crop. In general, Colonial diets are apt to be low in first class proteins, in fats and in green leafy vegetables and fruits. Calcium and phosphorus also appear to be widely deficient. Deficiency of vitamin D is not widely reported, but the remaining vitamins appear to be lacking to a larger or smaller extent. The general conclusion is that "there are few of the constituents considered necessary in Europe for a nutritionally adequate diet which are generally available in sufficient quantities in the Colonial Empire". There are few parts of the Colonial Empire, or indeed of any tropical country, where the diet of the majority of the population is at present anything like sufficient for optimum nutrition. Diets are often insufficient in quantity and still more often insufficient in quality. If they are bulky, the bulk is too often made up of foods that do not supply all the needs of a balanced diet. Judged by European standards they lack variety and they lack protective value.

* Cmd. 6050, price 3*s*.

† Cmd. 6051, price 2*s*. 6*d*.

It is not easy to distinguish between the effects of food deficiency and those of infections, such as hookworm or malaria. Nevertheless, the effects of malnutrition are serious. Firstly, there are many diseases which are known to be directly caused by dietary deficiency. Secondly, there are others which, if not directly caused by them, are at least aggravated by them. Thirdly, an insufficient diet weakens resistance to diseases of all kinds and leads to inefficiency and lack of wellbeing. The committee has no doubt whatever that these conclusions are correct. It suggests that they should have great significance for Colonial Governments and affect many aspects of Government policy. Money spent on improving nutrition should be a sound investment yielding its dividend in the increased welfare of the community as a whole.

Means for Improvement.

The general conclusions reached by the committee only confirm the belief which has been growing up in informed circles during recent years. It has realised, however, that the analysis of the present situation is only a part of its duty and the greater part of the report is taken up with the discussion of ways and means of improving matters. The committee throughout has insisted on the necessity of a realistic and practical approach to the problem. "In Colonial conditions it is not useful to say that the aim should be that every man, woman and child should consume four or five or six pints of milk a week and that until they do so they cannot be well nourished, for such a state of affairs is far beyond the realms of possibility". The exact measures to be taken must vary in each territory and the committee puts forward a large number of ideas and recommendations, all of a practical nature for consideration by each Colonial Government.

Causes of Malnutrition.

The two main causes of malnutrition in the Colonial Empire, apart from the prevalence of diseases, which often have a weakening effect, are first and most important, the low standard of living, and secondly ignorance coupled with prejudice. A subsidiary factor in some territories is the increase of population.

The low standard of living does not necessarily mean in the Colonial Empire, as it would mean in this country, a deficiency of money resources, for in many parts of the Colonial Empire the people are still largely independent of money. What it does mean is that the foodstuffs which they produce, supplemented by the money obtained from the sale of produce, wages, or some other source, are very often insufficient to provide adequate nutrition in addition to all their other needs. The reason for this is not necessarily that the available income is badly distributed, that

some have too much while the majority have too little. Much more fundamentally it is due to the fact that the total income of the community is at present too low.

Agriculture and Nutrition.

The problem is thus largely one of economic development. Primarily in the Colonial Empire economic development means improvements in agricultural production. Predominantly the people of the Colonial Empire get their living by agriculture. Accordingly, two chapters are devoted to agricultural questions. Close co-operation between the Departments of Health and Agriculture is stressed. It is for the Health Departments to say what is deficient in the existing state of nutrition and for the Agricultural Departments in consultation with the Health Departments to consider how the deficiencies can best be met. The aim of the Agricultural Department should be the establishment of a balanced agriculture which, while safeguarding soil fertility meets the food requirements of the people and gives them the greatest cash value for the products which they sell.

Family production of food to meet family needs is regarded as most important. It is a great safeguard against the worst social and economic effects of fluctuations of income from money crops, and it has many other merits. Accordingly Colonial Governments should make it their policy that as many people as possible should grow at least part of the foodstuffs which they themselves consume, that, where a labourer for wages is more or less permanently employed on an estate, the estate owner should be encouraged to provide him with land for a garden or for maintenance of animals, and that where there is a landless class they should be provided with at any rate some land, even if not enough to give a complete livelihood.

Improvements in Dietary.

In considering the desirable additions to Colonial diets the first requisite is that the energy needs should be supplied. At the same time energy-giving foods are not sufficient by themselves unless the other requirements for a good diet are also present, and it is recommended that a good working rule would be to endeavour to increase the quantity of foodstuffs consumed by increasing the variety.

New Crops.—Where population presses hardly upon the land the energy yield of foodstuffs per acre is all important. It is shown that animal products have a low energy yield per acre but cereals and particularly rice a high yield. The various crops that may be useful for the improvement of nutrition in the Colonial Empire are next considered. A combination of cereals and legumes is nutritionally valuable and specially mentioned are soya beans (if properly prepared), groundnuts, red palm oil and fruits and green leafy vegetables generally. As regards animal husbandry, increased consumption of animal products is regarded as most desirable (although their energy yield per acre is low) and an increase of animal husbandry should also be beneficial from an agricultural point of view. After discussing the importance of putting the cattle population of Africa to economic uses the committee mentions that other animals may also play a valuable part. The tethered milch goat in some parts of the Colonial Empire may, they think, be very valuable, for the reason that the goat is hardy and not particular as to its diet, that its milk is not likely to be contaminated with tubercle bacilli and that it is an animal well suited to the means of the peasant farmer. Poultry and in some territories pigs may also be a useful adjunct.

Milk and Milk Products.—A separate section is devoted to the question of milk and milk products. The low consumption of milk products is one of the most striking factors in Colonial diets. Generally little or no milk is consumed after weaning. Milk is often actually disliked. There seems to be no prospect of quantities, anything like adequate by Western standards being brought within the reach of Colonial peoples, and the dangers of milk in tropical and sometimes primitive conditions, are pointed out, because fresh whole milk, besides being the most valuable of all foods, may also be one of the most dangerous. These dangers are less present in curds and cheese, since the souring of the milk reduces the liabilities of contamination. There has been a substantial development of ghee manufacture of recent years in some parts of the Colonial Empire. This at least ensures the consumption of fats and of some part of the other constituents of milk without danger to health, but it is wasteful from the point of view of the community as a whole unless the skimmed milk which remains is also used. Skimmed milk is regarded as standing next to whole milk in the order of nutritive value of foods, since it contains all or practically all of the valuable constituents of whole milk apart from its fats and certain vitamins.

Part of the deficiency of milk supplies may be made up by imports of milk products, and in a valuable appendix the committee relates the cost of the various kinds of imported milk to the nutritive value obtained from them. This is a task which has never before been attempted. The conclusion reached is strongly in favour of imports of dried skimmed milk, at any rate for use in bulk. The committee finds that £1 spent on dried skimmed milk will give a very much larger quantity of proteins, calcium, phosphorus, iron and the B vitamins than the same amount spent on any other form of manufactured milk.

Fish.—The committee thinks that fish is the animal product which may perhaps be more useful than any other in supplementing Colonial diets. It accordingly welcomes the recent appointment of a committee to assist in the development of Colonial fishery resources.

Harvesting, Preservation, Storage, Processing and Cooking of Foods.

A chapter is devoted to discussing the various methods of harvesting, storing, preserving, processing and cooking of foods. Perhaps the most important part of this chapter is the appendix by Dr. Platt on the subject of the processing of rice. It has long been known that beriberi, which is a disease prevalent among rice-eating people, is due to a deficiency of vitamin B1 in the diet. Rice in its natural state contains a quantity of vitamin B1 which should be sufficient, but it is often destroyed before the rice is consumed. Until recently it has been thought that the destruction occurred chiefly during the process of milling. The appendix to this report shows that even the most highly milled rice may contain quantities of the vitamin which are very nearly adequate if it is properly stored and cooked. This is a conclusion which may be of great importance in rice-eating territories, since so far efforts to persuade people eating highly milled rice to change their habits have met with small success.

Purchase of Foodstuffs.

In a chapter dealing with the purchasing of foodstuffs it is pointed out that the development of an internal trade by the provision of markets and communications may have a very important effect on nutrition. Imports of foodstuffs are only substantial in relatively few territories. In general the committee recommends that unless there is very good reason to the contrary they should be admitted free of duty. If it is desired to assist local production there is a good deal to be said for a subsidy rather than a protective duty.

Nutrition of Paid Labourers.

One of the chapters is devoted to the nutrition of paid labourers. The committee says that "there is unfortunately abundant evidence that in some occupations where it is not customary to provide the employee and his family with food the wages earned are not sufficient to provide adequate nutrition for the worker and his family." The obvious reaction to such a situation is to say that the rate of wages should be increased. "Apart altogether from considerations of humanity and social justice, it may well be that increased wages may be justifiable as a purely economic proposition". For various weighty reasons however an increase in wages may not always be the most immediately practicable way of improving nutrition. Various other measures could be taken by employers which would redound to their own advantage as well as to that of their labourers. In East Africa where it has been the normal practice for the employer to provide food for his labourers there is a considerable body of evidence to show that money spent on making the provision adequate for good nutrition is directly remunerative to the employer. This has certainly been the experience of the large mining companies on the Rand and in Northern Rhodesia, but with few exceptions those engaged in other occupations have not been quick to profit from this experience. The committee recommends that where it is customary to provide food for labour there should be legislation laying down as precisely as possible what the scale of rations given should be. "We regard it as almost certain, that in Africa, quite apart from humanitarian considerations any money spent on bringing the food consumed by the labourer up to an adequate well-balanced ration will be money well spent from the immediate point of view of an employer." Where it is not customary for the employer to provide food, as in West Africa and in other parts of the Colonial Empire, the committee still thinks that he would often find it in his own interests to give more attention to the food of his employees than he does at present. On certain estates in Ceylon, Malaya, Mauritius and elsewhere a certain amount of attention has been given to the subject, but, "too often at present the employer is apt to regard his responsibilities as finished when he has paid his wage bill". The committee recommends that employers should do their best to make gardens available for their employees and thinks that they would often find it to their own interest to provide foodstuffs of special nutritive value, such as meat, free or at cheap rates. "This is" according to the committee "a case where the interests of finance and humanity coincide".

Education and Propaganda.

A long chapter is devoted to the factor of ignorance and the need for education and propaganda. The committee recommends special instruction on nutritional subjects to officers appointed to the Colonial Service. In regard to the education of the general population the greatest possible emphasis is placed on the importance of the part played by women. "In many parts of the Colonial Empire it is hardly too much to say that they alone affect the nutrition of the people. In some parts of Africa . . . it is the women who decide what food crops to grow, who actually grow them, who reap them, store them, cook them and serve them. . . . If the family buys its foodstuffs it is the women who do the marketing. . . . Further, the women are naturally responsible for the feeding of infants and young children and their own diet during pregnancy and lactation can have a great influence on the health of their children. Finally, it is the women who are the home makers and who set the standard of life for the whole family. It is difficult therefore to exaggerate the importance of the women's part." The committee therefore hopes that there will be a considerable increase in the education of women and greater use of women as Government welfare agents, school mistresses, health workers, midwives, &c.

With regard to the technique of welfare propaganda, "no attempt has yet been made to collate and consider as a whole the experience gained in the Colonial Empire". The committee regards the subject as so relevant to the question

of nutrition that it not only considers the relative merits of several methods of propaganda but also suggests some twenty general principles which should be taken into account by any one who has to plan welfare propaganda. These should be very helpful to Colonial Governments. In regard to the education of the young in schools, the committee emphasises the importance of the school garden in rural schools and of the teaching of agriculture and rural health to boys: also domestic science, in its simpler forms, to girls. In a good many parts of the Colonial Empire experiments have been made in the provision of meals and milk to school children, and the committee recommends that these should be extended so far as cost permits. In particular experiments with the use of dried skimmed milk are recommended.

The Need for Further Knowledge and Co-operation.

In two final chapters it emphasizes the need for further knowledge in regard to tropical nutrition and for co-operation between various Government Departments if there is not to be waste of effort. As the result of a recommendation made by the committee some time ago an organisation has already been set up under Dr. B. S. Platt to organise nutritional surveys in the Colonial Empire. The first survey in Nyasaland is now nearly completed and promises to yield most valuable results; other surveys are being organised in East Africa and it is hoped that before very long progress will also be made in other parts of the Colonial Empire.

It will be seen that the report covers a very wide field. It is to a large extent pioneer work, since a comprehensive survey of the question has never before been attempted. As the Secretary of State points out in his foreword, " it is only within the last few years that the importance of this question has begun to be fully appreciated and that it has entered people's heads that Governments should seriously and actively concern themselves about it ", and he is confident that the committee's report " will do much to promote wise policies and improved standards of nutrition in the Colonial Empire ".

THE PINK BOLLWORM IN THE WEST INDIES.

Mr. F. A. Squire, in a recent report* based on investigations carried out from 1936 to 1939, gives an account of the pink bollworm of cotton *Platyedra gossypiella* Saund., in the West Indies.

The pink bollworm was first recorded from the West Indies in 1920 and within two years had become established throughout the Lesser Antilles. Infestation during the flowering phase is often high and may prevent the setting of bolls or the young bolls may be shed. During the boll phase, at least part of the lint from infested cotton becomes stained or, due to waterlogging and the entry of putrefying organisms, the whole boll may rot, and the seed may be damaged or destroyed.

Mating of adults is curiously restricted to the hours from 1 to 5 a.m., the peak being at 3.30 a.m., and takes place once. Under experimental conditions in St. Vincent, oviposition continued for 15 days, reaching a peak on the fourth night after mating, and an average of 111 eggs was laid per female. The egg stage only lasts 4 days. There is considerable larval mortality between eclosion and penetration of the boll. In the early stages of infestation the larvae prefer bolls of about 30 to 36 days old, but as the crop ages, the pest is forced onto ripening or even ripe bolls. This causes the larvae to go into a resting stage or diapause, in which condition they are able to survive the close season. Pupation takes place either inside or outside the boll, and the pupal stage lasts from 7 to 10 days.

Mr. Squire has made a detailed study of the causation, nature and origin of the larval diapause in this species and his results have been published elsewhere. He rightly refers to this stage as the crux of the problem of the control of the pink bollworm. The practical implications of this resting stage are obvious when it is realised that at least a third of the larvae found in sheltered positions are able to survive the close season. Situations harbouring resting larvae are found in ginneries, cotton seed store houses, cotton houses, peasant dwellings and elsewhere, and it is of the utmost importance that such places be kept in a sanitary condition. Heat treatment of cotton seed by a Simon's heater is advocated rather than fumigation, and the fitting of a recording thermograph to the machine is recommended. Conditions such as are found in St. Vincent do not favour the resting stage in the soil, for heavy rain penetrates deeply causing the pupation and emergence of diapausing larvae.

Mr. Squire stresses the fact that a 3½ months close season is essential if the pink bollworm is to be controlled, is of the opinion that September is the best month for planting cotton throughout the Lesser Antilles, and condemns the inter-island traffic in seed cotton during the cotton season. Although the pink bollworm has a number of secondary hosts, they are imperfect and become unimportant when there is a 3½ months close season attended by a good clean up of cotton.

The investigation of other ecological methods of control, such as the development of resistant cottons and the use of natural enemies of the pink bollworm, has scarcely been touched and remains largely for the future.

E. McC. C.

* The Pink Bollworm, *Platyedra gossypiella* Saund., in the West Indies; by F. A. Squire, Imperial College of Tropical Agriculture, Trinidad, B.W.I., 1939.

REVIEWS.

THE INSECT LEGION.

By Malcolm Burr, D.Sc., F.R.E.S. *James Nisbet and Co., Ltd.*, London, 1939, pp. 321. Price 12*s*. 6*d*.

Man's greatest rival and deadliest enemy is the subject of this book, which is somewhat reminiscent of "The Insect Menace" by Dr. L. O. Howard published in 1931. Dr. Burr tells us that the total number of species of insects is probably not far short of a million, which is far more than the total number of plants and nearly four times as many as all other species of animals together. Insects are the cause of half the world's mortality and each year they destroy enough food to supply 200 million people. Such is the insect legion, an ever-present menace waging unceasing war on humanity.

Dr. Burr divides his book into four parts. The first of these on "Insects Themselves" gives a popular account of insect biology and includes eight chapters. The second part on "Insects and Man" comprises seven chapters, in which the great importance of insects to man is emphasised from medical, veterinary and agricultural points of view. The chapters on the economic entomological front, on beneficial insects and on insects used as food and in medicine are among the best in the book. Some of the photographs, which illustrate the book, are quite impressive, such as that of an African termite nest and of soil erosion in Tanganyika. The latter is an indirect result of the presence of the tsetse fly, being brought about by the overcrowding of cattle in belts not infested with the fly, resulting in overgrazing with the inevitable consequence of soil erosion. "Insects and Life" is the title of the third part. This deals with the history of insects in past ages, and the reviewer feels would have been better omitted.

In the fourth part an account is given of the history of entomology in ancient and modern times. Dr. Burr's attempt at biblical exegesis is well worth reading. He refers to the appointment of Beelzebub as fly control officer as anticipating the action of a certain African government by some 3,000 years, describes the plagues of Egypt as exceptionally violent outbursts of chronic endemic pests, which were mainly entomological, and shows at some length that Moses was a good applied entomologist who has not been happy in his translators.

Dr. Burr refers to some important landmarks in entomology in more recent times, such as the foundation of the Royal Entomological Society of London in 1833, the First International Congress of Entomology in 1910 and the foundation of the Imperial Institute of Entomology in 1913. The book concludes with some interesting information on the employment of entomologists in the British Empire. The author does not hesitate to quote Dr. Neave, who points out that "the United States spends at least £2,000,000 a year in the war on insects and employs not less than 500 trained entomologists. The British Empire, with a population more than four times as great, spends little more than one-fourth of this figure, and employs less than 300 entomologists". Referring to agricultural pests alone, Dr. Neave states that "though the insect problems of the United States are on a vast scale, they are limited in variety, and are not especially dangerous to the world as a whole. But the responsibility of the British Empire, with its territories scattered throughout the world and so extensive in the tropics, and concerned with a far greater range of pests and crops, is a much heavier one".

E. McC. C.

* * *

LAND, LABOUR AND DIET IN NORTHERN RHODESIA.

By Audrey I. Richards, published by the International Institute of African Languages and Culture, *Oxford University Press*, 1939, pp. 423+16 figs.+3 maps, price 30*s*.

From a field survey of the Bemba tribe of Northern Rhodesia, Miss Richards has collected valuable data on the social, cultural and economic life of a primitive people. She presents the results of this exhaustive survey in a very readable form, well supported by photographs, maps, and tables.

The Bemba tribe is decidedly backward according to European standards, and the whole scale of values is very different from that of more "civilised" communities. Food, consisting almost entirely of millet eaten as a hard porridge, is the dominant interest of the tribesmen. Miss Richards very wisely therefore devoted the opening chapters of her book to analysis of the Bemba diet and the Bemba's attitude to food ; only in the later chapters does the author discuss the more technical aspects of the agricultural production of the district:—soil selection, land tenure, methods of cultivation, &c.

To the non-technical reader this book will prove very interesting and instructive reading ; to the technical reader, whether a student actually of African problems or of sociology generally, this book will be of undoubted value.

A. L. J.

ERRATUM.

A Summary of Experimental Work on Varietal Resistance of Sugar Cane to *Tomaspis Saccharina* 1936-39 XVI, No. 10, October, 1939.

Page 238, Table I, last line :
For 65.6 *read* 18.8.
For 18.8 *read* 65.6.

SUGAR NOTES.

(Compiled by the College Department of Sugar Technology.)

Artificial Rubber from Sugar.

Ernst Kleiber (assignor to Hevapar S.A., of Geneva, Switzerland) has recently taken out a patent of great apparent interest, the first claim of which is as follows: A method of obtaining a product having the appearance and the physical and chemical properties of natural plantation rubber, which comprises treating with hydrochloric and nitric acids a carbohydrate of the group consisting of the sugars, sugar derivatives, and wastes from the manufacture of sugar, thickening the product thus obtained by means of turpentine, neutralizing by means of a base, and drying.* Fuller details of the process will be published later on receipt of the complete specification. No doubt many research chemists will at once put such a process to the test to determine to what extent the product produced thus by the polymerisation of sugar and turpentine really resembles natural rubber and the cost of making such a product.—(*Int. Sugar Jr.*, Vol. XLI, No. 486, p. 238, 1939.)

* * *

The International Sugar Agreement.

Contrary to the rather hasty supposition put forward in certain marketing circles, especially in New York, the International Sugar Agreement does not cease to exist just because a state of war rules between certain countries in Europe. Article 51 of the said Agreement provides for such contingencies as the outbreak of hostilities. According to it any Contracting Government may, if it becomes involved in hostilities, apply to the Council for the suspension of its obligations under the agreement. If the application is denied, such Government may give notice of withdrawal from the agreement. The Council must make a decision within 60 days in respect of any applications, and any decision to withdraw on the part of a Contracting Government shall take effect only three months after the date of the receipt by the British Government of the notice of withdrawal. There is also the provision that if any Government gives notice of withdrawal, any of the other Contracting Governments shall have the right at any time during the ensuing three months also to give notice of their withdrawal. Actually, down to September 15th, no Government had applied to the Council for a suspension of its obligations, so no question of withdrawal had then arisen, all the more as the Council have at most 60 days wherein to decide whether to release a country from its obligations *sine die*.

It is of course too early to say whether the Council will be able to carry on with its rules and obligations during the course of a possibly long war. A good deal of latitude in the application of the provisions may prove necessary to meet the needs of those countries that cannot conveniently carry out their full obligations. But on all counts it seems desirable that the Sugar Agreement should remain in existence during the course of the war (even if its full activities are restricted) so that when hostilities are terminated the Council can pick up the thread where it was dropped. The complete abrogation of all the provisions of the agreement just because certain of the signatories are at war with one another would open the door again to unrestricted production and wipe out all the good that the agreement has already laboriously accomplished. — (*Int. Sug. Jr.*, Vol. XVI, No. 490, p. 371, 1939.)

* * *

Utilization of Bagasse in the Philippines.—*By R. C. Pitcairn.*

About a dozen years ago the accumulation of bagasse around many of the Centrals in the Philippine Islands became so great that disposal became a serious problem. Since that time increasing attention has been directed to its utilization in ways which would contribute to the welfare of the industry and its operatives.

During the 1925–26 crop season a bagasse-baling machine was put into operation. By leaving air spaces between bales piled under open roofing, the moisture content (50 per cent.) under our climatic conditions drops to approximately 24 per cent. in four months. This air-dried bagasse is then suitable for fuel. It is stored in four open storage sheds which have a total storage capacity of 180,000 bales.

This utilization of baled bagasse became so extensive that in 1934 an improved baling machine was installed, a portable piling machine being used to facilitate the handling of the bales. Within three years bagasse had entirely replaced firewood as fuel. Split bales fed into the fire-boxes of the 23-ton Baldwin locomotives involved no changes in the grate bars, the only change being an additional spark-arresting screen on the stack.

An accessory use of these locomotives was in connexion with a steam weed burner for keeping the trackway clear. This device was made of old materials and consisted of a 1½-inch pipe connexion between the dome cap of the locomotive and the front end of a carriage provided with an inverted horizontal steam spray. When so used, the locomotive operates at 160 lb. boiler pressure and travels at two to three miles per hour. Under conditions in the Philippines, the operation is repeated at intervals of approximately two months.

Stoves for the home burning of baled bagasse were constructed of six reinforced concrete blocks, and distributed without charge to the employees and labourers. Baled bagasse was also used for

* U.S. Patent, 2,150,068, 1939.

fuel under open kettles in cooking on the haciendas. Baled bagasse has also replaced large quantities of fuel oil, particularly during the harvesting season when the load on the Diesel engine is heavy.

There still remained a surplus of the product, to take care of which there was installed in 1935 an incinerator with blower and separator, similar in type to those used in the lumbering industry in the United States. At the end of each week during its operation the ash is loaded into cane cars and delivered to the planters for use as fertilizer. This installation has further proven itself an important factor for cleanliness at the mill. — (*Int. Sugar Jr.*, Vol. XLI. No. 490, pp. 401–402, 1939.)

ENTOMOLOGICAL NOTES.

Introduction of Beneficial Insects into Puerto Rico.

Work on the introduction into Puerto Rico from Brazil of *Larra americana* Sauss., for the control of *Scapteriscus vicinus* Scud., is recapitulated in a report by Dr. G. N. Wolcott. Some mortality of the Sphecid was caused by the spraying of the aeroplanes conveying them with pyrethrum just before they reached Puerto Rico.

Investigations in the autumn, made in view of proposed experiments on the value of liberating artificially reared individuals of *Trichogramma minutum* Riley to supplement the control of *Diatraea saccharalis* F., on sugar-cane by those already present indicated that, in autumn, high rainfall is favourable to the parasite. *Trichogramma* naturally controls the moth-borer during the time of high rainfall, and when rainfall is high during most of the year, natural control is commercially effective. In irrigated regions where egg-clusters are scarce, few eggs are parasitised, and the damage to the cane is much greater. The number of egg-clusters increases after heavy rainfall, and parasitism may reach 100 per cent. It appears to be unaffected by temperature. In 1937, the numbers of mature larvae of *Diatraea* per ton of ripe cane were 248 and 542 for the north coast where the annual rainfall is high, and the south coast where it is low, respectively.

Introductions of other beneficial insects included 88 adults of the Chalcid, *Dirihinus giffardi* Silv., from Hawaii for the control of fruit-flies of the genus *Anastrepha*, and sufficient numbers for liberation at the end of the year were reared on puparia of the house-fly (*Musca domestica* L.). A list is given of six native parasites bred from *A. fraterculus* var. *mombinpraeoptans* Sein and *A. suspensa* Lw. The Braconid *Opius anastrephae* Vier., which was obtained from both species, was the only one that exercised any effective control, the percentage parasitism by it of *A. mombinpraeoptans* ranging up to 49.9. No recoveries have as yet been made of *Ipobracon rimac* Wolc., or various Tachinids, all introduced during 1935 and 1936 for the control of *Diatraea saccharalis* F., on sugar-cane. Examples of *Microdus (Bassus) stigmaterus* Cress., parasitising 4.8 per cent. of the larvae of *D. saccharalis* were recovered in January, 1936, for the first time since the liberation of this Braconid some years previously, but none was found in larvae collected in August, 1936, after a severe drought, or in March, 1937. The Tachinid, *Lixophaga diatraeae* Tns., was the only native parasite reared from *D. saccharalis* ; the percentage parasitism by it averaged only 9.6, but it is of economic importance under favourable conditions.

The Coccinellids, *Azya trinitatis* Mshl., and *Cryptognatha nodiceps* Mshl., introduced from Trinidad in 1936 against *Aspidiotus destructor* Sign., have become well established, and consignments of adults of both species were sent to Santo Domingo in May, 1937. Early in 1937, *Hambletonia pseudococcina* Comp. and *Anagyrus coccidivorus* Doz. were introduced from Hawaii for the control of *Pseudococcus brevipes* Ckll. on pineapple. These Encyrtids were reared in the laboratory, and later, 2,417 adults of *H. pseudococcina* and 179 of *A. coccidivorus* were liberated. Their life-cycles in the laboratory lasted 26 and 21 days respectively. *H. pseudococcina* has apparently become established ; very few males were produced, whether the females were fertilised or not, so that reproduction in this species may be considered parthenogenetic.

Three native wasps observed to be predacious on larvae of *Laphygma frugiperda* S. & A. on maize were identified as *Polistes crinitus* var. *americanus* F., *P. major* P. de B., and *Mischocyttarus phthisicus* F. *Sceliphron caementarium* Drury was present in the same maize field in smaller numbers, but was not actually seen feeding on *L. frugiperda*. An undescribed Bethylid of the genus *Perisierola* near *nigrifemur* Ashm. was the only native parasite of *Platyedra (Pectinophora) gossypiella* Saund. on cotton.—(*Rev. Appl. Ent.*, A, Vol. 27, pp. 435–436 and pp. 502–503, 1939.)

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Soil Types and *Tomaspis saccharina* in Trinidad.

Mr. P. E. Turner and Mr. C. F. Charter, in their preliminary survey of the soil types of sugar estates in Trinidad, review the distribution of cane varieties, describe and classify the more important types of soil and make recommendations as to the general suitability of the soil groups to noble or hardy varieties or to hybrids of the two. Reference is made to the evidence that the liability of sugar-cane to attack by froghoppers (*Tomaspis saccharina* Dist.) is dependent on the suitability of the soil for oviposition, and its recovery from damage on the fertility of the soil, with special reference to lime-status, on natural drainage and on the capacity of the soil to supply moisture during rainless periods. A tentative classification of soils in relation to attack by *T. saccharina* and subsequent froghopper blight is given.—(*Rev. Appl. Ent.*, A, Vol. XXVII, p. 384, 1939.)

CHEMICAL NOTES.

(Compiled by the College Department of Chemistry and Soil Science.)

Sulphuric Acid in Plant Sap.

From the marine alga *Desmaresita*, a juice has been obtained which had a pH value of 0.78, total acidity of 0.425 N, chloride and sulphate contents of 0.157 N and 0.539 N, respectively. No malate, succinate, tartrate, or citrate were detectable, and only a trace of oxalate. Assuming that the acid present is sulphuric acid, almost 21 per cent. of the solid material was sulphuric acid. The alga causes the disintegration of other algae when placed with it in a vessel of sea water.—(*Ind. Eng. Chem., News Edit.*, Vol. 16, No. 1.)

* * *

Catalase Activity in Soils.

Soils rich in organic matter owe their high catalase activity to moulds and bacteria which are inhibited by sterilization and by poisons. Much of the activity in soils low in organic matter is due to hydroxides of iron and manganese. The functions of the activity from both sources are identical.—(*Soils and Fertilizers*, Vol. I, No. 2.)

* * *

Role of Manganese in Soil Fertility.

Manganese sulphate produces an effect in soil similar to that of manganese peroxide or potassium permanganate in hastening the decomposition of organic matter, and in increasing the availability of plant nutrients. In the soil, the soluble manganese sulphate passes into the insoluble condition, mainly as manganese peroxide. —(*Soils and Fertilizers*, Vol. I, No. 2.)

* * *

Fate of Soluble Potash Applied to Soils.

When soluble potash is added to soils, it soon dissolves in the soil solution and then moves about by diffusion and the movement of the soil water. Some of this potash may be absorbed immediately by growing plants, and a small amount may be lost by leaching, especially if heavy rainfall ensues. In most cases the major portion reacts with the base exchange material of soils, and through cation exchange becomes fixed as an exchangeable base. In this condition the potash is readily available to plants, since exchange of hydrogen from the carbonic acid which is excreted in large amounts by plant-roots for the potassium in the exchange material brings the potassium into solution as the carbonate, so that it may be absorbed by plants. Thus, as long as the potassium remains in exchangeable form, it is readily available to plants.

It has been found that in many soils a portion of the exchangeable potassium passes over in time to a non-exchangeable form. Some evidence has been obtained indicating that this non-exchangeable form is muscovite-mica or a closely allied mineral. It has also been found that alternate wetting and drying hasten the fixation in non-exchangeable form. To explain this, it has been suggested that, when the exchange material is saturated with potassium and the material is then dried (which is supposed to bring the layers or plates of the crystal lattice together), the presence of the potassium offers such strong attraction as to prevent re-expansion of the crystal lattice and thus re-entrance of water and opening up of the crystal lattice, causing the potassium to become trapped in non-exchangeable form. Other cations, such as sodium and calcium, which are smaller in size than potassium, are not fixed or trapped in this manner.

From a practical standpoint the question arises: how can this fixation in non-exchangeable form be lessened or prevented? Application of potash fertilizers at a depth of several inches instead of at the surface, so as to lessen the influence of alternate wetting and drying, suggests itself as a measure worthy of attention. Localized application of fertilizer and the use of granular forms should help considerably. Introduction of organic matter, which supplies organic base exchange material, should also be helpful, since entrance of potassium in the organic exchange renders the potassium safe from fixation in non-exchangeable form as secondary muscovite. —(*Ind. & Eng. Chem.*, Vol. 30, No. 8.)

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Synthetic Resins and Propellors.

After extensive research in close collaboration with the Air Ministry a new protective covering for wooden airscrews has been developed that is to take the place of the hitherto used linen fabrics. These were usually glued to the wood and varnished, but since the edges had to be protected specially by sheaths of brass, the weight was increased to such an extent that trouble through cracking and denting was often experienced. The new covering consists of a fabric envelope treated with a special flexible synthetic resin of a rubbery nature that is pressed closely to the blades by a new hot-molding process. This method provides a tough layer of protective material which is bonded very firmly all over the wood. Special reinforcement is incorporated in the covering along the leading edges, thus rendering metal sheaths superfluous. The new material is claimed to be superior to other protective covers in being unaffected by ultra-violet light, oils, and gasoline. It is very resistant to moisture and general weather conditions, and offers effective protection to the wood.—(*Ind. Eng. Chem., News Edit.*, Vol. 16, No. 4.)